



Nitrification inhibitor DMPP mitigated N_2O emissions and decreased N_2 losses in a low-nitrate vegetable soil after application of manure

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Background

In China, amounts of organic manure as basal fertilizer application along with flooding irrigation usually resulted in large N_2O emissions from intensively protected vegetable soils. However, little attention paid on the N_2O emission bursts after application of manure, in a newly established vegetable soil with a low-nitrate content. The nitrification inhibitor, 3,4-dimethylpyrazole phosphate (DMPP), can be used to reduce N_2O emissions from agricultural soils, little is known about how DMPP affect N_2 emissions and gaseous nitrogen ($\text{N}_2\text{O}+\text{N}_2$) losses.

Experimental Approach

We conducted a microcosm experiment in a robotized incubation system under an aerobic (O_2/He) condition. Dried chicken manure was applied with and without DMPP to a protected vegetable soil. Two drying-rewetting events occurred during the 19 days monitoring period, and the relevant soil properties (e.g., NO_2^- , WFPS, DOC, DON, SMBC) were analyzed.



Results

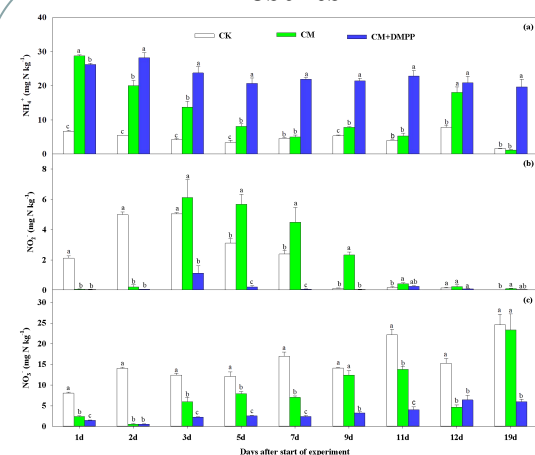


Fig. 1 Changes of soil inorganic nitrogen (NH_4^+ , NO_2^- , NO_3^-) concentration

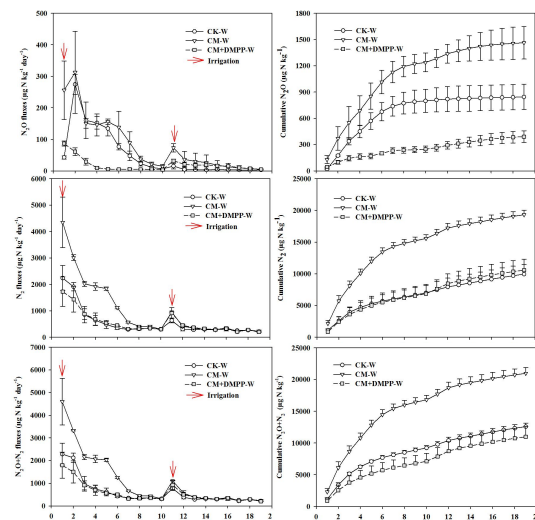


Fig. 2 N_2O , N_2 and $\text{N}_2\text{O}+\text{N}_2$ fluxes and their cumulative production during the aerobic incubation

DMPP addition significantly reduced N_2O emissions from the protected vegetable soil by 77.0% and remarkably decreased N_2 emissions and overall $\text{N}_2\text{O}+\text{N}_2$ losses (compared with manure alone) by 51.9% and 54.0%, respectively.

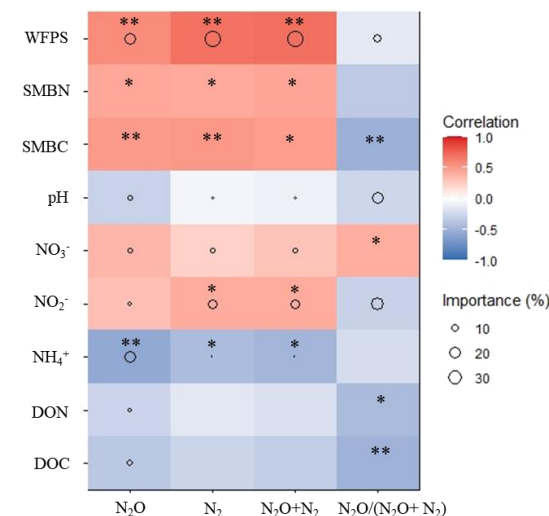


Fig. 3 Correlation analysis between soil properties and N_2O , N_2 , $\text{N}_2\text{O}+\text{N}_2$ fluxes and its $\text{N}_2\text{O}/(\text{N}_2\text{O}+\text{N}_2)$

Pearson analysis showed that soil N_2O fluxes were significantly related to soil WFPS, NH_4^+ , SMBC and SMBN, whereas N_2 fluxes were significantly correlated with soil WFPS, SMBC, NO_2^- , NH_4^+ and SMBN during the whole incubation. The fluxes of $\text{N}_2\text{O}+\text{N}_2$ were positively correlated with WFPS, NO_2^- , SMBC and SMBN, whereas negatively correlated with NH_4^+ . Moreover, the ratio of N_2O to $\text{N}_2\text{O}+\text{N}_2$ ($\text{N}_2\text{O}/(\text{N}_2\text{O}+\text{N}_2)$) was positively correlated with NO_3^- , and negatively correlated with DOC, DON and SMBC.

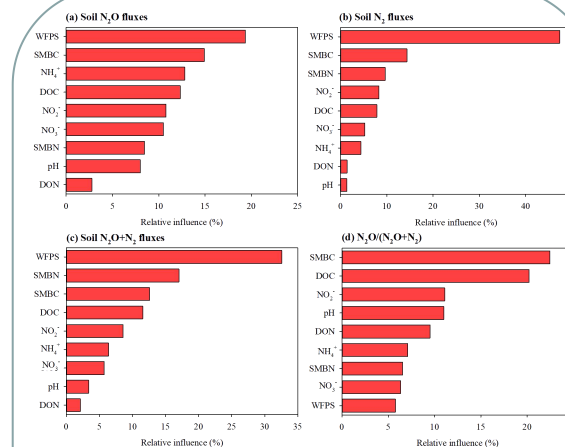


Fig. 4 The relative influences of soil properties on N_2O (a), N_2 (b), $\text{N}_2\text{O}+\text{N}_2$ (c) fluxes and $\text{N}_2\text{O}/(\text{N}_2\text{O}+\text{N}_2)$ (d) during the aerobic incubation

An aggregated boosted tree (ABT) analysis further indicated that the relative influence of WFPS, SMBC and NH_4^+ on N_2O fluxes were 19.4%, 14.9% and 12.8%, respectively. Moreover, the relative influence of WFPS on N_2 fluxes was the largest (47.4%), followed by SMBC and SMBN (14.3% and 9.66%, respectively). In addition, the relative influence of WFPS, SMBN and SMBC on $\text{N}_2\text{O}+\text{N}_2$ losses were 32.6%, 17.0% and 12.6%, respectively, and the relative influence of SMBC, DOC and NO_2^- on $\text{N}_2\text{O}/(\text{N}_2\text{O}+\text{N}_2)$ were 22.5%, 20.2% and 11.1%, respectively.

Conclusion

Our data show that DMPP combined with manure can significantly reduce N_2O and N_2 emissions in a low-nitrate newly established vegetable soil, and their emissions were strongly affected by WFPS.